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Preprint from the 1987

BUREAU OF MINES MINERALS YEARBOOK

Beryllium

UNITED STATES DEPARTMENT OF THE INTERIOR

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This publication is a chapter from the current Bureau of Mines Minerals Yearbook, comprising *Volume I, Metals and Minerals; Volume II, Area Reports: Domestic; Volume III, Area Reports: International.* The separate volumes of the Yearbook are sold by the Superintendent of Documents, Washington, D.C. 20402.

Beryllium

By Deborah A. Kramer[1]

Domestic production of beryllium ore decreased slightly in 1987, but consumption of beryllium materials increased, particularly beryllium-copper alloys. Growth in the automotive electronics, computer electronics, and telecommunications markets was partially responsible for increased beryllium demand. Developmental work and feasibility studies were conducted on three beryllium ore properties in the United States and Canada, which, if successful, could increase the North American supply of beryllium raw materials. Exports of beryllium metal and imports of beryl ore increased significantly from those of 1986. Over 75% of the metal exports was shipped to Taiwan.

Beryllium materials continued to be used in advanced technology applications such as defense electronics, computers, microwave radar devices, and lasers. However, other materials were substituted for beryllium in aircraft brakes, one of its traditional applications.

Domestic Data Coverage.—Domestic production data for beryllium are developed by the Bureau of Mines from two separate, voluntary surveys of U.S. operations. Typical of these surveys is the "Beryllium Mineral Concentrate and Beryllium Ore" survey. Of the 11 operations to which a survey request was sent, all responded, representing 100% of the total mine shipments shown in tables 1 and 5.

Table 1.—Salient beryllium mineral statistics

(Short tons of beryllium metal equivalent unless otherwise specified)

	1983	1984	1985	1986	1987
United States:					
Beryllium-containing ores:					
Mine shipments	227	241	230	251	242
Imports for consumption, beryl[2]	66	53	66	63	92
Consumption, reported	280	309	316	318	356
Price, approximate, per short ton unit BeO, imported calcined beryl at port of exportation	$124	$89	$87	$88	$84
Stocks, Dec. 31	281	235	190	195	181
World: Production[3]	r405	364	389	p306	e279

eEstimated. pPreliminary. rRevised.
[1]Based on a beryllium metal equivalent of 4% in beryl.

Legislation and Government Programs.—In June, the General Services Administration (GSA) solicited bids to supply 60,000 pounds of beryllium metal to the National Defense Stockpile (NDS). GSA reportedly received bids from two companies, Brush Wellman Inc. and Advanced Metallurgy and Testing Corp. (AMT), to supply all or part of the 11,150 pounds of grade-A structural beryllium and 48,850 pounds of instrument-grade metal. At yearend, no contract to supply the metal had been awarded. Government stocks of beryllium materials in the NDS at yearend were beryl, 17,987 short tons; beryllium-copper master alloy, 7,387 tons; and beryllium metal, 290 tons. Stockpile goals for these materials were beryl, 18,000 tons; beryllium-copper master alloy, 7,900 tons; and beryllium metal, 400 tons.

The 100 most hazardous substances found in Superfund sites reportedly were ranked in 4 priority groups, based on chemical toxicity, frequency of occurrence at Su-

perfund sites, and potential for human exposure. Beryllium was included in the first group of substances. Under section 110 of the Superfund Amendments and Reauthorization Act, 1986 (Public Law 99-499), the Environmental Protection Agency and the Department of Health and Human Services were required to develop toxicological profiles for the substances on the priority lists. A draft toxicological profile for beryllium was issued in October 1987. The profile was intended to characterize the toxicological and health effects information for beryllium and to identify and review pertinent literature.[5]

DOMESTIC PRODUCTION

Beryllium ore shipments declined from those of 1986. Production of beryllium metal and beryllium-copper master alloy increased significantly, but beryllium oxide ceramic production declined slightly.

The only major domestic producer of beryllium ores was Brush Wellman. The company mined bertrandite from its open pit in Spor Mountain, UT, and processed bertrandite, imported beryl, and domestic beryl into beryllium hydroxide at its mill in Delta, UT. Small quantities of beryl were recovered in the United States, principally as a byproduct during the mining of pegmatite minerals.

Drilling began early in the year at the Sierra Blanca Prospect near El Paso, TX, which was a joint venture operation between Cabot Corp. and Cyprus Minerals Co. Cominco American Incorporated announced that it would spend up to $600,000 over the next 2 years to study the feasibility of its joint venture property in Juab County, UT. Cominco American's partner in the joint venture was Beryllium International Corp. Cominco American estimated that it would cost about $15 to $16 million to bring the property into production.

Cyprus and Cabot reportedly formed a new company, AMT, to produce beryllium metal. AMT would lease facilities from NGK Metals Corp. at Temple, PA, to produce beryllium metal for a small market segment. AMT also planned to develop new near-net-shape production technology and provide testing services for beryllium metal consumers. Plant startup was scheduled for yearend 1987.

CONSUMPTION AND USES

Consumption of beryllium in 1987 increased from that of 1986 because of strong demand in the electronics industry. Increased growth of the automotive electronics, telecommunications, and computer markets, which use beryllium components, were important in boosting domestic beryllium consumption.

Three principal products accounted for most of the beryllium consumed in the United States—beryllium-copper alloys, beryllium metal, and beryllium oxide. Beryllium-copper alloys, containing from 0.5% to 2.0% beryllium, represented the most widely used beryllium product, and they were used in applications such as aerospace, computer, defense, electrical machinery, oil and gas exploration, automotive electronics, and telecommunications. The principal use of beryllium metal was in aerospace and defense systems. Specific uses of beryllium include rocket motors, aircraft brakes, military targeting systems, inertial guidance systems, and infrared satellite surveillance. High-power electronic circuits, microwave radar devices, and lasers were some of the uses for beryllium oxide ceramics. All of these applications utilize the high-strength, lightweight, and high-thermal-conductivity properties of the metal and the oxide. Small quantities of beryllium were consumed in the form of aluminum- and nickel-base alloys.[6]

PRICES AND SPECIFICATIONS

Throughout the year, the price range for beryl ore quoted in Metals Week was $78 to $85 per short ton unit (20 pounds) of contained beryllium oxide. At yearend, the following prices for beryllium materials were quoted in American Metal Market, in

dollars per pound, except for beryllium-copper master alloy, which was given in dollars per pound of contained beryllium:

Vacuum cast ingot, 97% pure		$225
Metal powder, in 5,000-pound lots and 97% pure		196
Beryllium-copper master alloy		160
Beryllium-copper casting alloy	$5.52	6.20
Beryllium-copper in rod, bar, wire		8.90
Beryllium-copper in strip		8.00
Beryllium-aluminum alloy, in 100,000-pound lots		260
Beryllium oxide powder		55.70

Brush Wellman reportedly increased prices on beryllium oxide powder twice since January 1985, when the $55.70 price was effective, but it did not announce them in the press. Effective January 1, 1986, the price for beryllium oxide powder was $59.30 per pound; effective January 1, 1987, this price increased to $61.35 per pound.

FOREIGN TRADE

Exports of beryllium metal more than doubled from those of 1986. Exports of beryllium-copper alloys were combined with data for other copper alloy exports by the Bureau of the Census and could not be separately identified. Some beryllium-copper alloy exports were identified through the Journal of Commerce Trade Information Service-PIERS. This computer data base service reports materials transported by ship and may not reflect the total quantity of beryllium-copper alloys exported. According to PIERS, 261,788 pounds (gross weight) of beryllium-copper alloys was exported, principally to France and Taiwan.

Table 2.—U.S. exports of beryllium alloys, wrought or unwrought, and waste and scrap,[1] by country

Country	1986		1987	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
Belgium-Luxembourg	560	$56	105	$63
Brazil	--	--	153	19
Canada	6,471	224	10,799	469
China	--	--	116	5
Finland	53	5	--	--
France	7,817	1,264	5,690	1,243
Germany, Federal Republic of	8,327	2,066	4,699	555
Hong Kong	--	--	6,000	20
Ireland	113	3	--	--
Israel	53	28	1,223	130
Jamaica	164	2	--	--
Japan	3,530	477	3,451	527
Korea, Republic of	2,253	22	1,063	43
Mexico	126	4	164	4
Netherlands	2,540	320	2,672	212
Pakistan	182	2	--	--
South Africa, Republic of	--	--	466	5
Spain	30,608	90	--	--
Switzerland	753	105	470	53
Taiwan	4,400	21	128,777	390
United Kingdom	11,263	2,897	4,971	888
Venezuela	597	4	--	--
Other	r26	r4	38	14
Total	79,556	7,394	170,408	5,013

rRevised.

[1]Consisting of beryllium lumps, single crystals, powder; beryllium-base alloy powder; and beryllium rods, sheets, and wire.

Source: Bureau of the Census.

Table 3.—U.S. imports for consumption of beryl, by country

Country	1986		1987	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Argentina	29	$18	35	$33
Brazil	759	646	883	745
China	502	497	599	490
France	183	112	721	552
Hong Kong	--	--	50	49
Macao	6	4	--	--
Madagascar	13	8	--	--
Mozambique	18	12	--	--
South Africa, Republic of	39	27	--	--
United Kingdom	--	--	23	8
Zimbabwe	--	--	81	64
Total	1,510	1,354	2,302	1,944

Source: Bureau of the Census.

Table 4.—U.S. imports for consumption of beryllium metal and compounds

Year	Beryllium-copper master alloy		Beryllium, wrought		Beryllium, unwrought and waste and scrap		Beryllium oxide and carbonate		Beryllium compounds n.s.p.f.	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
1985	18,930	$87	769	$176	110,689	$89	2,532	$123	7,332	$135
1986	24,180	114	20,467	50	22,487	55	248	3	2,010	42
1987	53,902	246	92,422	290	18,294	159	6,669	99	29,434	90

Source: Bureau of the Census.

WORLD REVIEW

Brazil.—Brazil's Institute of Nuclear Energy (IEN) planned to begin small-scale production of beryllium metal by yearend. The proposed plant was expected to produce beryllium for use as a neutron moderator in a reactor that the IEN planned to construct to produce radioisotopes. Raw material for the beryllium plant reportedly will be provided by the Farquhar Foundation in the State of Minas Gerais. After an initial pilot-scale plant is completed and the operating parameters determined, the IEN planned to double the plant's capacity to 264 pounds per year. When in operation, it will be the only beryllium metal plant in market economy countries outside the United States.

Canada.—Hecla Mining of Canada Ltd. reportedly completed a market analysis and process development to recover beryllium from ore at the Thor Lake property in the Northwest Territories, which Hecla planned to develop in a joint venture with Highwood Resources Ltd. of Canada. Hecla approved the expenditure of $2.5 million in 1988 to construct a pilot plant to generate detailed engineering data for commercial plant development. The Thor Lake property contains approximately 1.8 million tons of ore reserves with an average grade of 0.76% beryllium oxide.

Zimbabwe.—CRM (Pvt.) Ltd. reportedly took over the activities of Mitmar (Pvt.) Ltd., the sole producer of beryl and mica. CRM planned to expand its beryl production and continue its exploration program for beryl.[4]

Table 5.—Beryl: World production, by country[1]

(Short tons)

Country	1983	1984	1985	1986[p]	1987[e]
Argentina	26	28	e17	e35	33
Brazil	1,039	1,551	967	e1,000	1,100
Madagascar[2]	r133	51	e55	e55	55
Mozambique	7	8	e7	e7	7
Portugal	3	11	2	(e)	--
Rwanda	35	49	30	(e)	--
South Africa, Republic of	23	1	6	3	3
U.S.S.R.[e]	2,100	2,100	2,100	2,100	2,100
United States[4] (mine shipments)	6,665	6,030	5,728	6,533	e6,062
Zimbabwe	52	21	42	114	120
Total	r10,083	9,850	8,964	9,897	9,480

eEstimated. pPreliminary. rRevised.

[1]In addition to the countries listed, China produced beryl, and Bolivia and Namibia may also have produced beryl, but available information is inadequate to formulate reliable estimates of production. Nepal reports producing small amounts. Table includes data available through Apr. 29, 1988.

[2]Includes ornamental and industrial products.

[3]Revised to zero.

[4]Includes bertrandite ore, calculated as equivalent to beryl containing 11% BeO.

[5]Reported figure.

TECHNOLOGY

Research personnel at Los Alamos National Laboratory reportedly constructed a prototype laser-spark-source spectrometer that can detect as low as 10 billionths of a gram of beryllium in a small sample in less than 3 minutes. Conventional filter analyses may take up to 8 hours. A patent for the laser-spark-analysis method used in the instrument was issued to the U.S. Department of Energy. Los Alamos reportedly is seeking companies to commercially manufacture and market the new detectors.

Brush Wellman announced that it began a $4.3 million expansion of its facility for forming near-net-shape beryllium parts directly from powder. The expansion was intended to make the metal more cost competitive with competing materials. When the expanded facility becomes operational in early 1988, Brush Wellman will be capable of producing near-net-shape parts by combinations of cold die pressing, cold isostatic pressing, vacuum sintering, and/or hot isostatic pressing.

The National Aeronautics and Space Administration planned to replace the beryllium heat sink component in the brakes of the space shuttle with carbon. Carbon materials reportedly can withstand braking temperatures up to 3,000° F compared with beryllium, which can withstand temperatures up to 1,000° F. A carbon heat sink also was claimed to be lighter, less costly, and longer lasting than a beryllium heat sink. Substitution of carbon for beryllium in the space shuttle followed the changing specifications in braking systems for heavier aircraft; the C-5B cargo aircraft, F-14 fighter aircraft, and 757 passenger aircraft were equipped with carbon brakes.

[1]Physical scientist, Branch of Nonferrous Metals.

[2]Toxicological Profile for Beryllium (U.S. EPA contract 68-03-3228, Syracuse Res. Corp.). Oak Ridge Natl. Lab., Oct. 1987, 94 pp.

[3]Taylor, B. A Review of Beryllium—The Metal, Its Oxide and Alloys. Ind. Miner. (London), No. 235, Apr. 1987, pp. 67-73.

[4]Industrial Minerals (London). Beryl and Mica Takeover. No. 234, Mar. 1987, p. 15.

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